

XIV. *On Bruchus-infested Beans.* By THEODORE WOOD.

[Read August 4th, 1886.]

IN the 'Entomologist's Monthly Magazine' for October, 1885, I published a short account of certain experiments made with beans infested by *Bruchus rufimanus*, Boh. These experiments, however, were carried out upon so small a scale that I did not feel justified in drawing any definite conclusions as to the true extent of the injury caused by the beetle. In the spring of the present year, therefore, I instituted an investigation upon a larger scale, and now beg to lay before the Society the results which I have obtained.

In the first place, I may perhaps be permitted to give a brief *resumé* of my last year's experiments. These were conducted with seed of a variety of broad bean recently introduced by Messrs. Carter & Co., of High Holborn, and entitled by them the "Leviathan," in consequence of the great size often attained by the pods. The packet which I received being only a small one, I sowed but twenty seeds, three of which had each been perforated by three weevils, five by two, and twelve by one only. In about a fortnight the young plants appeared, seemingly in no way injured by the damage wrought to the seed. The growth for a time was strong and vigorous, no sign of weakness or disease could be detected, and the condition of the plants, until the time for flowering arrived, was all that could be desired. With the reproductive impulse, however, came a change. Notwithstanding the apparent health of the plants, the blossoms were few and small, the foliage rapidly withered, and in several cases the plants died without producing a single pod.

The first three plants, grown from seed perforated by three weevils, were very unproductive, one being altogether barren, while the remaining two bore but three pods between them, none of which attained to maturity. The next five, raised from seed tenanted in each case by

two weevils, bore in all six pods, of which five came to perfection; two of these plants, however, were barren. The remaining twelve, the seed of which had sustained but one perforation, produced twenty-three pods, of which not more than ten arrived at their full size. Only one of these latter plants, however, was altogether unfruitful. The twenty plants thus bore among them thirty-two pods (six to a plant being with this variety considered the normal number), and even of these barely one-half attained to their full development. That the seed itself was not in any way deficient, apart from the injury caused by the beetles, was sufficiently proved by the fact that the plants raised from the remainder, which were free from the weevil, yielded an average crop. I therefore concluded that the presence of the *Bruchus* in the seed, although only in exceptional cases affecting the germinating powers, was yet highly prejudicial to the reproductive capabilities of the adult plant. I also found that, with one exception, the plants raised from weevilled seed were altogether passed over by *Aphis rumicis*, which attacked almost every other bean-plant in the garden, and destroyed at least one-third of the entire crop before it was fit for gathering. From this I inferred that the sap of the weakened plants was of too deteriorated a character to be suitable for *Aphis* nourishment. I have since found reason to modify the former of these conclusions in some cases, and in some degree.

Before proceeding to discuss results, however, I will specify the conditions under which the second series of experiments were carried on. I procured in all five varieties of infested beans, two of which, the "Leviathan," already mentioned, and the "Seville Longpod," were kindly supplied by Messrs. Carter, who inform me that they have devoted much attention to the possibility of eliminating the damaged from the sound seed. The remaining three varieties consisted of the well-known "Early Mazagan," and of two more belonging to the longpod section.

From the packets supplied to me I selected the damaged beans, and sorted them out in accordance with the number of perforations sustained by each. Towards the end of March I planted them in well-dug and thoroughly-manured ground, under the most favourable conditions for their subsequent development. Of the

whole number of seeds sown not more than three or four failed to germinate. Three, however, gave rise to plants entirely devoid of colouring-matter, which grew to the height of five or six inches only, produced a few yellowish-white leaves, and then withered away. The plants proceeding from the remainder, however, were to all appearance strong and healthy, rapidly increased in size, and showed no sign whatever of weakness or disease. But, just as in the first instance, the show of blossoms, when in due course they appeared, told a different tale, and it became evident that in most cases the reproductive powers were seriously diminished by the presence of the weevil in the seed. Several plants were altogether barren; others boasted of no more than one or two small flowers; while scarcely five per cent. of the whole number could be credited with the average yield.

Contrary to my expectations, however, I could not find that the produce of the individual plants was proportionate to the number of perforations sustained by the seed. One plant, for instance, the seed of which was tenanted by no less than six weevils, nevertheless bore nine pods, of which seven arrived at maturity. On the other hand, several raised from seed attacked by one beetle only were barren. So little rule was there in this respect, indeed, that I was compelled to relinquish my original intention of classifying the plants according to the number of perforations sustained by the seed, and to content myself with ascertaining the whole number of pods produced by each variety, and striking an average therefrom by dividing the result by the number of plants.

The distribution of the pods was briefly as follows:—

The plants of No. 1 variety (Carter's "Leviathan") were 86 in number, four of the 90 seeds originally planted having failed to germinate. These 86 plants produced 480 pods, of which 201 shrivelled away almost immediately. Six pods, as before stated, form the normal yield in this variety. In the diseased plants, however, taking only the developed pods into the account, the average number was rather less than three and a half. At the same time, as if to falsify all deductions, one plant, the seed of which had been tenanted by three weevils, bore no less than ten mature and two immature pods; just double the ordinary number.

Of variety No. 2 (Carter's "Seville Longpod"), I sowed

67 seeds. The plants which resulted produced among them 270 pods, of which no less than 127, or nearly one-half, shrivelled away while quite small and immature. The yield per plant, therefore, barely exceeded two pods, as against a normal average of six or seven.

Of variety No. 3 (Longpod) 51 seeds were sown. Of these three failed to germinate; the remainder bore in all 248 pods. Exactly fifty of these 248, however, failed to develop, and thus the average yield of mature pods was slightly more than four to each plant, the normal average again being seven.

Of variety No. 4 (Longpod) 45 seeds were sown. The plants raised from these bore 204 mature and 55 immature pods, an approximate average of four and a half to each. The normal average in this variety is again seven.

Of variety No. 5 ("Early Mazagan"), 44 seeds were sown, none of which were perforated by more than two weevils. The plants resulting from these seeds, all of which germinated in due course, produced 359 pods, of which only nineteen failed to arrive at maturity. The average yield to each plant, therefore, was as nearly as possible eight pods; the normal number.

Judging, therefore, by the criterion of the average number of pods produced, this latter variety was the only one which remained practically unaffected by the damage caused to the seed; being by far the most robust, this fact is less striking than it at first sight appears. Of the remainder, the two longpod varieties (Nos. 3 and 4), which are tolerably hardy in constitution, were each deprived of nearly one-half their reproductive capabilities, the "Leviathan" (No. 1) of almost exactly one-half, and the "Seville Longpod" (No. 2), perhaps the most delicate of all, of rather more than two-thirds.

Another and a still more striking fact, however, has yet to be recorded, namely, that with the exception of those borne by the "Early Mazagan" plants, more than one-fourth of the pods, although large and healthy in appearance, proved upon examination to contain nothing more than the withered germs of the beans which they should have enclosed. In as many more, one or at the most two, perfect beans were found, while in scarcely fifty pods altogether were the contents fully developed in both size and number. Several pods, again, were

aborted in a very curious manner, but this may possibly have been due to other causes. The appearance of these unproductive pods may be seen by the coloured sketches which I now exhibit, and which were most carefully drawn to scale from accurate measurements.

The total produce, therefore, of four out of the five varieties experimented upon was so greatly diminished as to leave no possible ground for doubt that the presence of the weevil in the seed is highly detrimental, affecting to a very considerable degree the reproductive powers of the future plant. At the same time, we have the curious fact that the number of weevils present, whether one, two, three, four, five, or even six, appears to influence but slightly the health of the plant and its produce, the mischief being apparently caused by the mere presence of the weevil, almost irrespective of its numbers in any individual case. It is also remarkable that certain of the diseased plants—if diseased we may justly term them—bore even more than the normal number of pods. This latter fact would seem to point to the conclusion that the amount of damage sustained by infested seed depends in some measure upon the position of the burrow. If the germ itself be penetrated the seed must necessarily be rendered sterile; and it is not impossible that the nearer the burrow is situated with regard to the germ the greater is the consequent injury. This point I hope to clear up in the course of future experiments.

It would also be both interesting and instructive to sow uninfested seed produced by diseased plants in order to ascertain whether the injury is transmitted in any degree to the second generation. This experiment I should myself have attempted, but that I was informed by Messrs. Carter that seed-beans of the more delicate varieties will not ripen in the English climate, but are principally imported from Southern Spain. And, as these varieties are those which suffer most severely from the presence of the beetle, I judged it useless to attempt the experiment with the more robust varieties only.

With regard to the aversion manifested by *Aphis rumicis* for the sap of the weakened plants, the almost total absence of the insect in this neighbourhood during the present season afforded me no opportunity of making further observations upon the subject. I found specimens,

however, upon three or four plants of the "Leviathan" variety which had resulted from seed perforated by from four to six weevils; but these, although they certainly bred, did so in but small colonies, and did not spread to the neighbouring plants.